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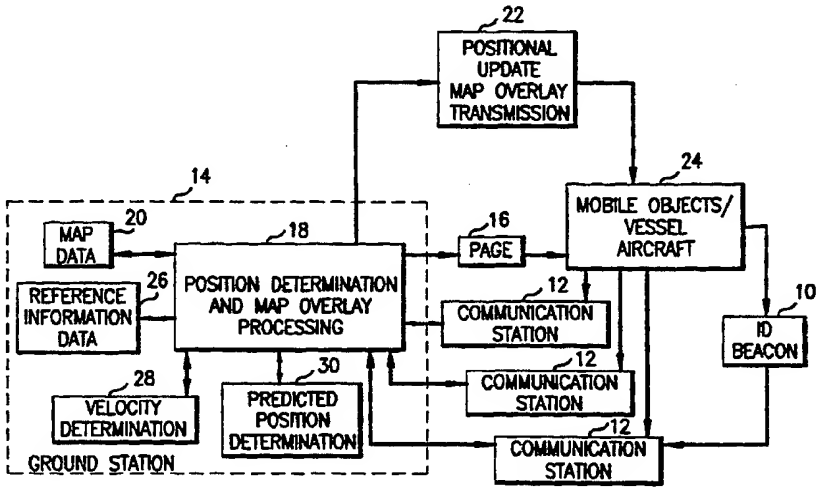

(57) Abstract

An earth based locating and map dissemination system wherein the locations of mobile objects in a monitored area are identified and then broadcast throughout the monitored area. Each mobile object being tracked in the monitored area carries a unique ID code device. A master ground station in a monitored area contains apparatus for paging each of the unique ID codes in the given area. The positions of each of the mobile objects carrying a unique ID code device may be determined by a bearing determination or a time delay determination based on the response to the paged signal. Alternatively, the page signal response may include the location coordinates of the mobile object as determined by a navigational system carried by the mobile object. The master ground station collects the position information for all of the mobile objects in the given area and then transmits those positions in a file throughout the given area. The position file information is coordinate encoded so that it may be superposed on a map of the area. In addition to the position files, the master ground station can transmit reference information that is also coordinate encoded. Further in addition to the position file, velocities of the mobile objects can be determined and distributed along with as predicted positions of the mobile objects based on their present position and velocity.

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LOCATING/MAP DISSEMINATION SYSTEM

BACKGROUND OF THE INVENTION

The present invention is directed to a system for disseminating map information providing the locations of mobile objects within a given monitored area.

In navigating through a harbor, around an airport or through a municipal street network a mobile object such as a boat, airplane or car can be greatly assisted by a map, particularly one that includes the locations of other mobile objects in the same vicinity. Systems are available for identifying the location of one's own mobile object. Other systems exist which provide a relative positioning of other objects relative to one's own moving object. Many of these systems however, are quite expensive and not available to individuals with private boats, cars or planes.

The present invention builds upon an earlier invention by the present inventor disclosed in U.S. Patent Number 5,051,741. In the earlier patent, the inventor discloses a locating system in which mobile objects carry transponders, the location of which is determined by paging a given area and monitoring the responses within a network of communication stations. The network of stations is set up so that the location of a mobile object can be generally determined within a triangular sector formed by three of the communication stations.

SUMMARY OF THE INVENTION

The present invention is directed to an earth-based locating and information dissemination system. In the given area served by the system, mobile objects each carry a unique ID code device. Each of these devices is paged throughout the given area. The position of the unique ID code devices is determined by their responses to their page. The position information is compiled for all the mobile objects in the area into a form that can be superposed on a

map image. In addition to the position of the mobile objects, the system may also provide the velocity of the objects and other reference information stored in association with various locations on the map image. For systems covering contiguous areas it is recommended that each system transmit its location information over a different frequency or make use of a different transmission protocol.

The mobile objects carry a receiver and a display device. A computing device connected to the receiver superposes the location information onto a map image for display on the display device.

The present invention can advantageously provide map and location information on all of the mobile objects in a given area and deliver that information to all of the mobile objects in the given area. The position information is transmitted in a file that can be used for display on a map of a given area. The locating function of the present invention is advantageously centralized so that each mobile object need not purchase an expensive locating system to make use of this navigational aid. Other objects and advantages will become apparent during the following description of the presently preferred embodiments of the invention taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a conceptual block diagram of the overall locating and map dissemination system of the present invention.

Fig. 2 is a schematic block diagram of a communication station of Fig. 1.

Fig. 3 is a schematic block diagram of a ground station shown in Fig. 1.

Fig. 4 is a schematic block diagram of a mobile receiver and processor for use in the mobile objects shown in Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, Fig. 1 provides a signal processing schematic of the position locating map dissemination system of the present invention. The system of Fig. 1 operates over a given area. Mobile objects 24 tracked by the system are each provided with a unique ID code. The system needs to be made aware of unique ID codes for all mobile objects 24 to be monitored in the given area. To this end, in a harbor or airport environment, each craft is provided with an ID beacon transmitter 10. Each mobile craft transmits its own unique ID continuously until deactivated by the system when the system has confirmed the entrance of the mobile object into the monitored given area. Preferably, the ID beacon is transmitted on a number of different frequencies sequentially at differing intervals of time. This helps to avoid data collisions with the other objects entering the area. Out of the several frequencies, it is hoped that at least one will be unique from the other mobile objects entering the monitored area so as to permit clear reception.

Communication stations 12 are distributed about the monitored area to provide the system with the ability to receive signals from anywhere in the monitored area. Any communication station 12 receiving a coherent signal on one of the ID beacon frequencies relays this information to a master ground-station 14 when addressed during an address cycle. The master station 14 pages all of the unique ID codes in the given area. When a mobile object receives a page with its unique ID code for the first time, it deactivates the ID code beacon as it is no longer needed in that area. The ID beacon transmissions are deactivated to more quickly open up frequencies for clear reception of the ID beacons.

Instead of transmitting ID code beacons, a cellular phone link may be used to call the master station of a given area to provide the ID code upon entering the given area. A

processor in the mobile object can be programmed to automatically dial the appropriate cell phone number and automatically communicate its ID code upon entering a given area monitored by a system of the invention. In a land-based system, mobile vehicles will often remain within a given area or contiguous monitored areas. The ground station 14 is provided with communication links to all ground stations in contiguous areas. The ground station 14 communicates the ID code of a mobile object to the ground station in the contiguous area into which the mobile object enters as it leaves its present given area. Thus, ID code beacon transmission may not be necessary in strictly land-based systems that are thoroughly covered by contiguous systems.

In an airport environment, the map dissemination system may be able to take advantage of the airport radar system. In response to a radar pulse, aircraft onboard systems return a coded reply. This reply could serve the function of an ID beacon by identifying a unique ID code.

Whatever method is used, the ID codes are provided to the master ground station 14. The codes are all added to the list of ID codes of all of the mobile objects in the given area. The ground station cyclically pages each of the ID codes in its list. The unique ID codes may be paged sequentially through the list, or alternatively, an algorithm may be executed for paging faster moving mobile objects more often than the non-moving and slower moving objects. Pages 16 are sent out over the one paging frequency assigned for use within the given area. Each mobile object is equipped with a transponder for responding to pages containing the unique ID code for that object. The transponder receives and processes signals received on any of four paging frequencies. By making four paging frequencies available, adjoining areas can each use one of the four frequencies without using the same frequency as an adjoining area.

The network of communication stations 12 may be arranged in a honeycomb pattern of triangles as disclosed in the applicant's previous U.S. Patent No. 5,051,741. The complete disclosure of U.S. Patent No. 5,051,741 is hereby incorporated by reference herein. Such an arrangement is set up such that the response from a transponder will most likely only be received by three of the communication stations. This will quickly locate the mobile object responding to the page to within a triangular sector outlined by the three receiving communication stations. In the present system, a more specific location for each mobile object is desired. The ground station and associated system may use any of the position determining methods 18 described below. These will work even if more than three stations receive the response to the page.

In order to obtain a more specific location for the mobile object, a comparison may be made based on the time delay before each of the communication stations receive the identification response from the transponder on a mobile object. Instead of time delay, the system may instead make use of phase comparison to obtain a specific location for the mobile object. Another method of position determination on the other hand, makes use of a bearing determination device. A simple example of a bearing determination device is a goniometer. The goniometer is a cross loop aerial that provides bearing information at each of the communication stations. The bearing determination devices are used at each communication station to get a bearing for the responding device. By reviewing the bearing information from two or more communication stations it is possible to identify a rather accurate position for the responding vessel.

An additional alternative for determining the position of the mobile object is for the mobile object itself to provide its own coordinate location. Some mobile objects may have the benefit of a sophisticated navigational system such as the Navstar Global Positioning System (GPS). These

systems may be used to obtain the coordinates for a mobile object. The mobile object may add the coordinate information to its response to the page. Thus, only a single communication station 12 need receive the response for the ground station system to learn the position of such a mobile object.

The ground station 14 cyclically interrogates each of the communication stations 12 to determine the positional information for each of the mobile objects in the given area. The information obtained from the communication stations is used in the ground station 14 to determine position coordinates for the mobile object. In the case of aircraft, three dimensional coordinates may be desired and determined by the system. Triangulation using three stations will provide a 3D coordinate fix relative to the three stations' positions. Bearing determination aerials determine direction implicitly and will thus provide 3D coordinates. Time and phase comparisons will only cause ambiguities in altitude in the instance that an aircraft is flying through the plane determined by the receiving antennas of the communication station. In general, knowing their actual positions will almost always exclude the erroneous suggestion that the aircraft is underground.

Map data 20 is available in a computer file to the ground station 14. The map data 20 is static and represents a geographical representation of the given area covered by the ground station 14. The ground station could operate in accordance with the present invention without the map data, if assurance could be provided that each of the mobile objects in the given area has ready access to the map data. This ready access may be provided through CD ROMs, for example. Preferably, each mobile object will have onboard access to total map image information. As such, the processing requirements are significantly reduced as compared to a system that would need to receive and process static map information upon entering each new given area. The alternative less preferred method is to have the map

data file transmitted throughout the given area on a separate frequency.

The ground station 14 broadcasts throughout the given area a file 22 with the position information of all the mobile objects in the given area. The file information 22 is arranged so that at the receiving mobile object, the position file can be combined with the map file to provide a display that contains representations of each of the mobile objects on the geographic map image in their specified locations as determined at the ground station 14.

In addition to graphic map data, the ground station 14 may be provided with reference information data 26. The reference information in the data file is associated with various locations on the geographic map. The reference data may include various overlays for superposition on the geographic map, each overlay displaying one or more characteristics. In a seaport environment such characteristics may include water depths. Also the file may include information such as where one could obtain gasoline or identification of available moorings and perhaps the prices therefore. Display screen software in the mobile objects provides the user with access to the various reference information. The reference information could be accessed as a complete overlay or alternatively as a response to an inquiry directed at a particular location. This is made possible since the reference information is provided in its file in association with the various locations on the geographic map. In a ground based highway location system or street location system for a city, the reference information may provide such information as where one could buy milk, where the local movie theaters are or where to buy gas. Another source of reference data may be from the mobile objects 24 themselves. For example, in an airport environment the airplane may respond to a page by providing a data file that includes various flight systems data. This data may then be made available from the ground

station through data files that relate the information to the location of the mobile object.

Additional processing information may be determined by the ground station 14. Since position information is continually being monitored for all of the mobile objects in the given area, the ground station 14 has information on the change in position over a period of time. Thus, a velocity determination 28 of the various mobile objects may be made in the ground station. This velocity information may be provided in the data file and transmitted throughout the given area to all of the mobile objects. Even further processing may take advantage of the velocity and position information to make a predicted position determination 30. By reviewing where each mobile object is heading and the velocity with which it is moving, the ground station may be able to provide a positional map of where the mobile objects in the given area are expected to be after a specified time delay.

We shall now review the individual components of the system in more detail. The communication stations 12 are spread in a network over the given area. The area density of the communication stations is determined by reception conditions. Existence of steel structures or other shielding obstacles in the area may increase the number of required communication stations. It is preferred that at least three communication stations be within receiving distance of any transponder in the given area. Map dissemination systems for different environments should operate at different frequencies so that a marine application for a city river would not be visible to a land-based motor vehicle application.

In Fig. 2, the contents of a communication station 12 are illustrated. A communication station may include ID beacon identification capability for determining the unique ID codes of mobile objects as they enter the given area. The communication station includes a number of receivers, illustrated by transmit/receive unit 42, tuned to different

frequencies which pick up the ID beacon data from an antenna 40. ID beacon data is extracted from received signals through a modem 44. Not every communication station 12 needs ID beacon determination capability. It is sufficient, for example, to supply only the communications stations whose reception areas extend to the perimeter of the given area with the ID beacon determination modules. Mobile objects entering an area, particularly in the marine environment, would be required to carry ID beacons. These would issue ID beacon signals consecutively over a plurality of access frequencies. The ID beacon signals are repeated periodically until deactivated by onboard circuitry reacting to a page signal. Once the ground station begins sending page signals with the ID code of a mobile object, that object's ID beacon is deactivated.

The communication station 12 includes a CPU 48 and signal analyzer 50 to identify the ID code in an ID beacon signal. An input/output device 46 provides the ID beacon data from the modem 44 to the CPU 48. Each of the ID codes determined to have been provided by a mobile object from a given area by the CPU 48 is sent to the ground station using a conventional communication technique. Using Fig. 2 to provide a simplified explanation, the CPU 48 provides the ID code data file to the input/output device 46. The data file is added to a carrier signal in the modem 44 for transmission through the transmitter/receiver 42 from the antenna 40. Requests for data from the ground station to the communication station are received through the antenna 40 and transmitter/receiver 42. Modem 44 extracts the data from the reception and inputs it through I/O device 46 to the CPU 48.

Communication stations 12 are provided in a network that can be used to determine the positions of the mobile objects over the given area. The honeycomb triangular network of U.S. Patent No. 5,051,741 may be used for distributing the communication stations. However, with the use of a bearing determination device 58 at the

communication stations, not as many would be needed and three communication stations might even be sufficient to cover an entire given area. The receiver 42 is tuned into all operational page response frequencies to pick up the response signals from the transponders in the mobile objects. For networks using the time delay method, the communication stations simply provide a time that a page response was received and return that time representing the receipt of the page response for an ID code to the master station.

In accordance with one embodiment of the invention, the communication stations are provided with a bearing determination device such as a goniometer 62. The goniometer is a cross-loop aerial that receives signals in a manner that allows for determination of the direction from which the signals came. This is used to determine the direction from which a page response was issued. These signals are provided through a receiver 60 to the bearing determination device 58. The bearing of the incoming page response signals are determined and delivered on a signal to a demodulator 164. The direction data is then input through the input/output device 46. The data is then made available to the CPU 48. The information may then be transmitted to the ground station by transmission through the antenna 40. At the ground station the various bearing determinations obtained from the plurality of communication stations may be combined to obtain the coordinates of the paged mobile object. The computer system at the communication station 12 is equipped with a data storage device 54 and additional system control software 52. The page response signal from the mobile object may in certain circumstances include coordinate information when the mobile object contains its own coordinate determining system. The entire page response is provided into the CPU 48 and can be analyzed by the system control software 52 for forming an appropriate file for transmission to the ground station. The communication

station may also include a video display unit 64 to facilitate on site testing of the station.

A master ground station shown in Fig. 3 controls the operation of the system for each given area. The ground station communicates with the communication stations. These communications can be carried out through an antenna 70 and a transceiver 72. Alternatively, standard cellular phone links or land lines could be used for these communications between the ground station and communication stations. A modem 74 and an input/output device 76 provide an interface between the transceiver 72 and a CPU 78 in the ground station. The ground station receives from the communication stations all of the unique ID codes for all mobile objects in the given area. The ground station keeps a list of all of the unique ID codes in the given area and cyclically proceeds through the list paging the given area with each of the unique ID codes. A page signal may include one or more ID codes. A page signal may also include an interrogation request asking the mobile object being paged to return certain information. Before a page, the ground station may alert the communication stations as to the ID code or codes that are about to be paged. In other words, the communication stations are primed. In the marine environment, however, priming is not required for all communication stations. Because the water vessels move relatively slowly, only the communication stations in the vicinity of the water vessel need to be primed.

For a page, the unique ID code is provided by the CPU through the input/output device 76 to a modulator 80. The ID code page signal is sent through transceiver 72 over the antenna 70 or, alternatively, through standard cellular phone links. Responses to the page signal are picked up by one or more of the communication stations. These responses are returned to the ground station through the antenna 70 and transceiver 72 or the alternatives. The ground station continuously polls all of the communication stations for

received responses from paged mobile objects and the ID codes of newly arrived mobile objects.

The response data gathered in response to the page signal are used to compile a position file with the locations of all the mobile objects in the given area. Some of the responses will be from mobile objects that have their own navigation systems and thus may directly provide their coordinates as data. For those that do not have the navigation capability on board, the responses received by the communication stations are used by the ground station to determine the position of the mobile object. The system control software 86 includes programs for determining position from the responses received by the communication stations. The particular program that is used is going to depend on the equipment used at the communication stations. Two examples already given are the use of a bearing determination device at each of the stations or the use of time delay measurements to derive or determine the precise location of each of the mobile objects.

The system control software 86 prepares the position file so that it is arranged in terms that can be easily superposed on a map image of the given area. The map file stored onboard is arranged as coordinate coded geographic data. The locations for each of the mobile objects is coordinate coded in the position file. Identifying information for each of the mobile objects is provided along with its location. Identification information provides the type of objects such as the type of boat or size of the boat. The information may be more specific so as to identify specifically the mobile object with an identifier that can be displayed on the screen and made useful for the observer. The CPU 78 provides the position information file through the input/output device 76 for transmission over the given area. The position file is made continually available. Its rate of change depends upon the rate of change of the dynamic information. Land vehicle traffic may change within a few minutes and thus processing and

modifying the dynamic file should be in accordance with this. At airports, the update ought to be more rapid, perhaps after every paging cycle. In general, the rate of change should provide information updates at a rate that addresses the environment being served.

In addition to the position file, the ground station may be used to determine the velocities of the mobile objects and/or predicted positions of the mobile objects. These additional files may be broadcast over the given area as is done with the position file. The predicted positions may be used to trigger an alarm if two mobile objects are predicted to come within less than a predetermined distance of one another.

A keyboard 96 and a video display unit 98 are provided at the ground station so that an operator can monitor the operation of the system. Map data for the given area and reference information data 26 are stored in data storage device 20. The reference information is associated with locations on the map image. The reference information is semi-static, changing occasionally. The reference information is transmitted continually, making it always available throughout the given area. The reference information is selectively displayed at the onboard system of a mobile object.

Referring now to Fig. 4, the onboard system carried by each of the mobile objects for receiving and processing the position and map information is now to be described in detail. When a mobile object enters an area being serviced by a locating/map dissemination system of the present invention for the first time, it is necessary for the system to learn the unique ID code for the transponder on the mobile object. The unique ID code data is stored onboard in a data storage device 112. A CPU 114 accesses the unique ID code data and provides it through an input/output device 116. The input/output device 116 provides the data through a modulator 118 to a transmitter 120. The modulator 118 and transmitter 120 are controlled to send the unique ID code

data on several specified frequencies. The use of several access frequencies is for minimizing common frequencies. For example, if two boats entered a monitored harbor from open sea, each having four ID access frequencies, it is likely that at least one of those frequencies will be distinct from those being transmitted by the other boat. The communication stations will determine through signal analysis which ID access frequencies are unique so that the ID codes can be detected.

The transmitter 120 sends out through aerial 122 the ID code data over the several different frequencies. Alternatively, particularly in the marine and air environments, the ID code data may be sent over a cell phone link. The transmissions are transmitted periodically at different time intervals and are issued continuously until some external signal deactivates the transmissions. When an ID communication station determines a unique ID code it transmits the ID information to the ground master station. It is presently contemplated that once the master station issues a page with the unique ID code, the page will deactivate the ID code transmissions. It is desirable to have the transmissions of the ID data codes deactivated so as to minimize data collisions. The use of the ID code beacon in the present invention is most suitable for the marine environment. Aircraft are normally equipped with radar triggered ID code transmitters which should suffice. On land, vehicles will normally be moving from one monitored area to another and the master stations can transfer the ID code between themselves.

The onboard system on each of the mobile objects acts as a transponder. Aerial 122 picks up page signals, position file transmissions and reference file transmissions. A page signal received from the ground station is processed through a receiver 124. Receiver 124 includes four tuned receiving circuits so that a page signal can be received in any monitored area. Each monitored area uses one of the four paging frequencies for broadcasting

page signals. The received signal is provided to a demodulator 126. The demodulated page signal is provided through an input/output device 128 to a CPU 114. The input/output device 116 and the input/output device 128 may be separate or may be a single device. The CPU 114 compares the received signal with the ID codes stored in the data storage device 112. A transponding operation is performed by comparing the incoming signal with its own ID code. A page signal will only be received upon positive identification of its own ID code. Other page signals are rejected. If the received page signal matches the unique ID code of the onboard system the CPU 114 will send a page response for transmission through input/output device 116, modulator 118, transmitter 128 and aerial 122. The frequency of the page response is determined by the frequency on which the page signal was received. Each of the four paging frequencies corresponds to one of four response frequencies. The page response is compiled in the CPU 114. The page response includes a fixed portion with an identification data file including the ID code to identify the mobile object. The page response may also be compiled with a variable portion with several parameters relating to the mobile object. Such parameters may include altitude, distress signals, "vehicle parked" signal, fuel level, or other such signals.

The response is completed within a predetermined time interval. The end of the ID transmission will be an end of message code so that any slight variation in transmission time will be accounted for by the receiver. The timing or direction of the page response may be used by the system to determine the position of the mobile object. Alternatively, some mobile objects may come equipped with a coordinate determining system 134 of its own. The coordinate determining system 134 may be a global positioning system (GPS) or other navigational system. For mobile objects that have the coordinate determining system 134 their ID page

response may be compiled to include in the variable portion the coordinates for the mobile object.

The receiver 124 in Fig. 4, in addition to representing the tuned circuits for the paging frequencies, may also represent four tuned circuits for receiving the position file from the master ground station of a monitored area. Alternatively, a variably tuned circuit can be set to the appropriate position file frequency corresponding to the paging frequency received by the mobile object. When a mobile object is near two or more monitored areas, it may be desirable to receive position file data from all of the two or more monitored areas. Moreover, rather than using different frequencies to distinguish from among the position files of adjacent monitored areas, a single frequency can be used for position files and adjacent areas can use different transmission protocols to identify and distinguish its position file from that sent out by a master ground station in an adjacent monitored area.

A position file containing the coordinates of all the mobile objects in the given area is transmitted throughout the given area periodically. The position file data is passed through demodulator 126 to the input/output device 128 to the CPU 114. Here the information is recognized as a position coordinate file. System control software 136 is used to decode the position coordinate file and meld it with the map data stored in data storage device 112 to create a map image that includes each of the mobile objects in the given area located on the map in its position as learned from the position coordinate file. For this, the software may use CD-ROM GIS map software. The system control software 136 may also include touch screen software, pull down menus, mouse driver, cursors, and other software for accomplishing the objects of the invention, said software being readily available or well within the ordinary skill of computer programmers to write.

The onboard system is equipped with a display unit 138 for displaying the map and the mobile objects in their

respective positions. In the harbor application various icons may be used on the display to illustrate the type of vessel that is located in any given position. Other identifying information such as a name may be provided alongside the icon representing a mobile object. The system software 136 may also include programs for changing the portion of the map image that is shown on the display unit. The onboard display unit may display the map information at different magnifications. This is made possible by storing the map image as a polygon encoded image. The software should also be provided with the ability to move the picture around rotating it as desired. Advantageously, the display unit can locate that part of the map through which the mobile object is traveling in the center of the display screen. The display unit 138 may advantageously be provided with a touch screen 139. Such a display device permits a user to access information by touching a location on the screen to request further information regarding that location. Alternatively the display may be provided by a head-up display 144 in which the operation of the mobile object sees the display projected in front. This permits the display to be seen without diverting attention too far from the forward direction of the mobile object.

A reference information file also keyed to the various positions on a map image may also be transmitted throughout the given area on a separate frequency by the ground station. On unique frequency for the reference information can be selected for use by all monitored areas because the information is semi-static. Alternatively, four frequencies each corresponding to one of the paging frequencies, may be distributed among the monitored areas. Receiver 124 may be provided with the additional receiving capacity to tune into the reference information frequency or frequencies. The onboard system can store the reference information in the data storage device 112. Informational questions can be made regarding a given area through the keyboard 140 or the touch screen 139. If an answer is available, the reference

information file in the data storage device 112 can report the answer to the video display unit 138. The reference information may be stored in association with a code to identify data type. For example, water depth may be one data type and tidal information may be another. The onboard system may choose to display any one or more of the reference data types superposed on the displayed map image. Text generated by the reference data is displayed horizontally on the screen in the vicinity of the associated geographic location. The system software controls the display so that the text remains horizontal even if the polygon encoded map is rotated on the display. The information about a particular location may also be quickly accessed by this onboard system. With the touch screen display 138, a user can touch a particular location and obtain a menu of information available regarding that location which can then be quickly accessed by touching an appropriate box displayed on the touch screen 138.

A data acquisition system 142 is connected between the mobile object's onboard controls and the onboard mapping system. This permits information such as speed, altitude, fuel level and other such data to be used and included in the page response signal. This information would be for use by an operator at the ground station. In exceptional cases, such as to announce emergencies, the information could be inserted into a position file that is transmitted throughout the given area.

When given areas are adjacent to one another accommodation needs to be made to avoid interference of the two systems. Preferably, each system operates on different frequencies. Alternatively each system operates with a different transmission protocol. The system for each given area will provide map information for that given area only. A mobile object in an overlapping region of two areas could receive and map out the two areas. Because all map information and reference information is coordinate encoded,

there is no processing problem at all in showing any part of the combined map image.

The present invention may be used in a variety of environments. It may be used in an airport monitoring the locations of planes and other vehicles on the ground. It may be used in harbors and restricted waterways to identify the locations of vessels on the water. The map information may be further provided with depth information to assist a vessel in navigating through the harbor. The system may be used on land to provide street map information for any given area. It should be understood that the present disclosure is for the purpose of illustration only and does not include all modifications or improvements which may fall within the scope of the appended claims.

I CLAIM:

1. An earth based information system for mobile objects, each carrying a unique ID code device, comprising:

means for paging each of the unique ID code devices present within a given area;

means for determining a position for each of the unique ID code devices within the given area; and

means for transmitting to the mobile objects the positions of all of the mobile objects corresponding to the paged unique ID code devices.

2. The information system of claim 1 wherein said transmitting means transmits the position of all of said plurality of mobile objects in a data file arranged for combination with a map file to enable display of a superposed image of any of said mobile objects positioned on a map.

3. The information system of claim 2 further comprising a memory device for supplying a data file containing information for recreating a static map image of the given area.

4. The information system of claim 3 further comprising means for transmitting data files of reference information individually associated with locations on the static map image.

5. The information system of claim 1 further comprising means for determining velocity of each of the mobile objects within the given area.

6. The information system of claim 5 further comprising means for determining predicted positions of all of the mobile objects in a predetermined time from present based upon the position and velocity of all of the mobile

objects and means for transmitting data files containing the predicted positions.

7. The information system of claim 1 wherein said means for determining position comprises means for receiving navigation coordinates from individual ones of said mobile objects.

8. The information system of claim 1 wherein said paging means comprises means for paging the given area with one of a plurality of unique codes, wherein the unique ID code devices each comprise a transponder responsive to one of said unique codes and wherein said means for determining position calculates position of a mobile object from the response of the transponder in said mobile object to a page with its respective unique code.

9. The information system of claim 8 further comprising means for providing said paging means with the unique codes of the mobile objects in the given area.

10. The information system of claim 1 further comprising a display means in each of said mobile objects for receiving the positions of all of the mobile objects within the given area.

11. An earth based information system for mobile objects, each carrying a unique ID code device, comprising:

a plurality of locating systems each including:

means for paging each of the unique ID code devices present within a given area serviced by said locating system;

means for determining a position for each of the unique ID code devices within the given area serviced by said locating system; and

means for transmitting the positions of all of the mobile objects corresponding to the paged unique ID

code devices in the given area serviced by said locating system, such that a receiver located in more than one of the given areas can distinguish among the transmissions from the locating systems.

12. The information system of claim 11 wherein said transmitting means for each locating system serving given areas that are adjacent one another transmits the positions of the mobile objects in its respective given area over a frequency different from a frequency used by the transmitting means of each other locating system serving an adjacent given area.

13. The information system of claim 11 wherein said transmitting means for each locating system serving given areas that are adjacent one another transmits the positions of the mobile objects in its respective given area using a transmission protocol different from a transmission protocol used by the transmitting means of each other locating system serving an adjacent given area.

14. An earth based information system for mobile objects comprising:

a plurality of transponders, each mobile object carrying one of said transponders;

means for repeatedly paging each of a plurality of mobile objects present within a given area;

means for determining a position for each of the plurality of mobile objects within the given area;

means for transmitting the positions of the mobile objects in the given area throughout at least the given area;

receiver means, carried on at least one of said mobile objects in the given area, for receiving the positions of the plurality of mobile objects in the given area; and

means, connected to said receiver means, for superposing the positions of any of the mobile objects in the given area onto a map image.

15. The information system of claim 14 wherein said means for determining position comprises means for receiving navigation coordinates from individual ones of said mobile objects.

16. The information system of claim 14 wherein said paging means comprises means for paging the given area with each of a plurality of unique codes and wherein each of said transponders is responsive to one of said unique codes and wherein said means for determining position comprises means for calculating position of a mobile object from the response of said transponder carried by said mobile object to a page including its respective unique code.

17. The information system of claim 16 wherein said transponders each include means for transmitting an identification data file in response to detection of its respective unique code.

18. An earth based information system for tracking mobile objects over a given area comprising:

a master station remote from said mobile objects, said master station including:

means for paging each of said mobile objects present within the given area using a unique ID code for each mobile object;

means for determining position coordinates for each of said mobile objects within the given area and for creating a file with the coordinates of said mobile objects; and

means for broadcasting the file with the coordinates of said mobile objects.

19. The information system of claim 18 further comprising means, located on a mobile object, for receiving the file with the position coordinates of said mobile objects and means, connected to said receiving means, for creating a map image of the given area that includes representations of said mobile objects located on the map image in accordance with the position coordinates determined by said position coordinates determining means.

20. The information system of claim 19 wherein said master station further includes means for broadcasting data files including encoded information associated with geographic coordinates for selective superposition onto the map image.

21. The information system of claim 20 further comprising selection means, located on a mobile object, for displaying selected information received from said broadcasting means superposed over the map image and a geographic map of the given area.

22. The information system of claim 21 wherein said selection means comprises a display screen on which selections are made by touching said screen.

23. The information system of claim 18 further comprising a plurality of transponders, each aboard one of said mobile objects.

24. The information system of claim 23 wherein each of said transponders includes means for responding to a page from said paging means with a fixed identification data signal.

25. The information system of claim 24 wherein each of said transponders further includes means for responding to a page with a variable information signal.

26. The information system of claim 18 wherein said means for determining coordinates comprises means for receiving navigation coordinates from individual ones of said mobile objects.

27. The information system of claim 18 further comprising means for identifying the unique ID code of each mobile object in the given area and providing the unique ID codes to said master station.

28. The information system of claim 18 wherein said master station further comprises means for identifying two mobile objects heading to within a predetermined minimum distance of one another and issuing an alarm in response thereto.

29. A method for disseminating mapping and position information to a plurality of mobile objects, each carrying a unique ID code device, in a given area, said method comprising:

paging each of the unique ID code devices present within the given area;

receiving a response from a unique ID code device paged with its unique ID;

determining a position for each of the unique ID code devices within the given area; and

transmitting to the mobile objects the positions of all of the mobile objects corresponding to the paged ID code devices present within the given area.

30. The method of claim 29 wherein said step of determining position comprises receiving navigation coordinates from unique ID code devices when they respond to a page.

31. The method of claim 29 wherein said step of determining position comprises calculating a position for a

unique ID code device based upon how much time elapsed between the step of paging the unique ID code device and the step of receiving a response from the unique ID code device.

32. The method of claim 29 further comprising the step of superposing representations of any of the mobile objects on a map image of at least a portion of the given area in accordance with the determined positions for the unique ID code devices carried by said any of the mobile objects.

33. A mapping system carried by a primary mobile object comprising:

means for receiving a paging signal including an ID code;

means for determining if the ID code of the paging signal received by said receiving means is equal to a predetermined unique ID code;

means for compiling a data file including information pertaining to the mobile object;

a transmitter for sending a response containing the data file when said determining means determines the ID code of the paging signal equals the predetermined unique ID code;

memory means for storing a data file representing a geographic map image;

display means;

means for receiving position information files with the data file representing a geographic map image to produce a map image for said display means that includes representations of mobile objects positioned on the map image according to the position information files.

34. The mapping system of claim 33 further comprising means for identifying the primary mobile object in the position information files so as to select and orient an appropriate portion of the geographic map image for use by

said combining means to produce the map image for said display means.

35. The mapping system of claim 33 wherein said display means comprises a touch screen which inputs commands in response to a person touching the screen.

36. The mapping system of claim 33 further comprising means for decoding position information files.

37. The mapping system of claim 33 further comprising means for determining navigational coordinates of the primary mobile object and providing the navigational coordinates to said compiling means.

38. The mapping system of claim 33 further comprising means for accessing information pertinent to a location in response to an input pointing to the location on the display means.

39. The mapping system of claim 33 further comprising magnification means for adjusting how large a portion of the map image is displayed on said display means.

40. The mapping system of claim 33 wherein said display means comprises a head-up display.

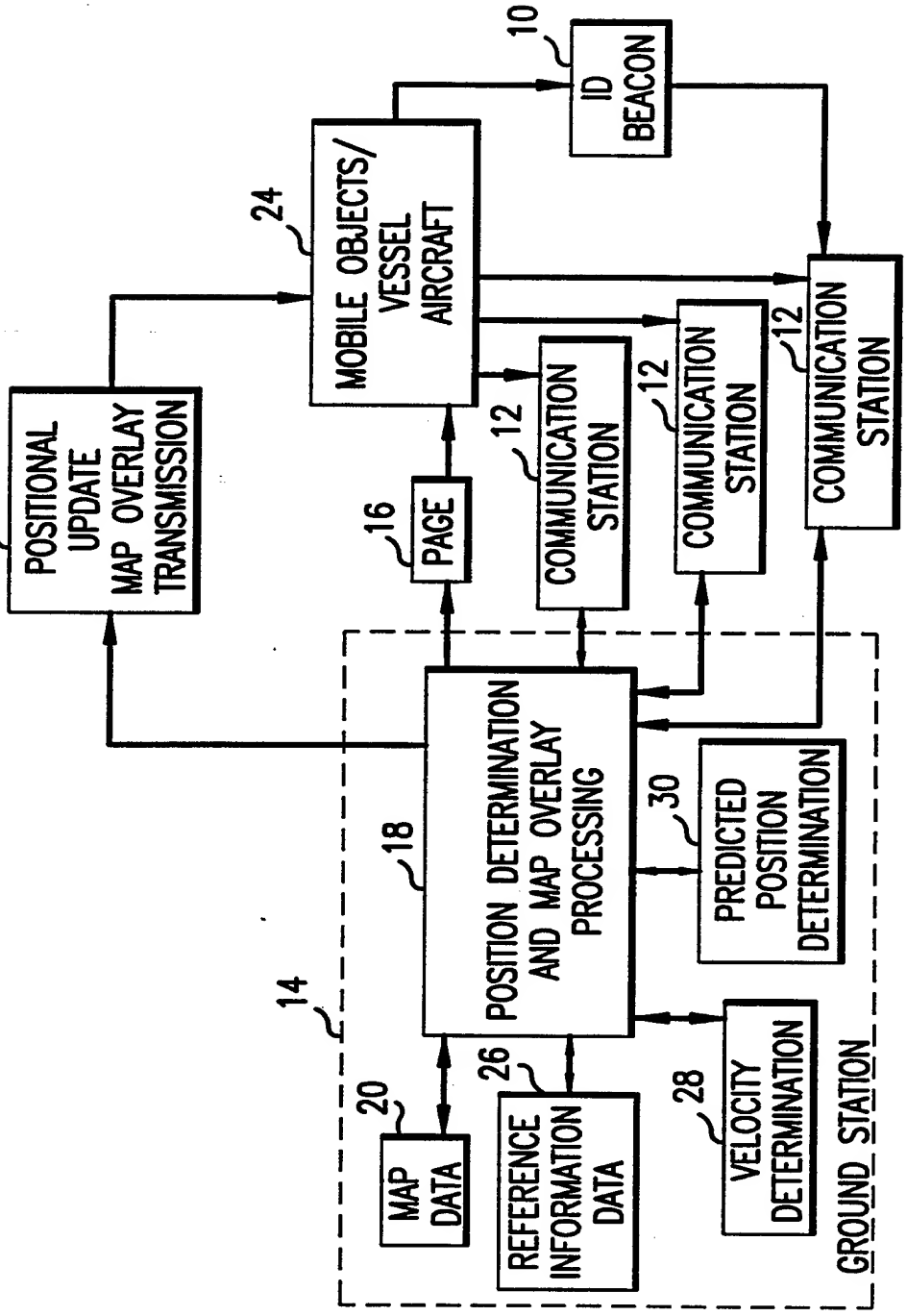
10
ID BEACON
24
MOBILE OBJECTS/ VESSEL AIRCRAFT
22
POSITIONAL UPDATE MAP OVERLAY TRANSMISSION
16
PAGE
12
COMMUNICATION STATION
12
COMMUNICATION STATION
12
COMMUNICATION STATION
18
POSITION DETERMINATION AND MAP OVERLAY PROCESSING
30
PREDICTED POSITION DETERMINATION
14
GROUND STATION
20
MAP DATA
26
REFERENCE INFORMATION DATA
28
VELOCITY DETERMINATION

FIG.1

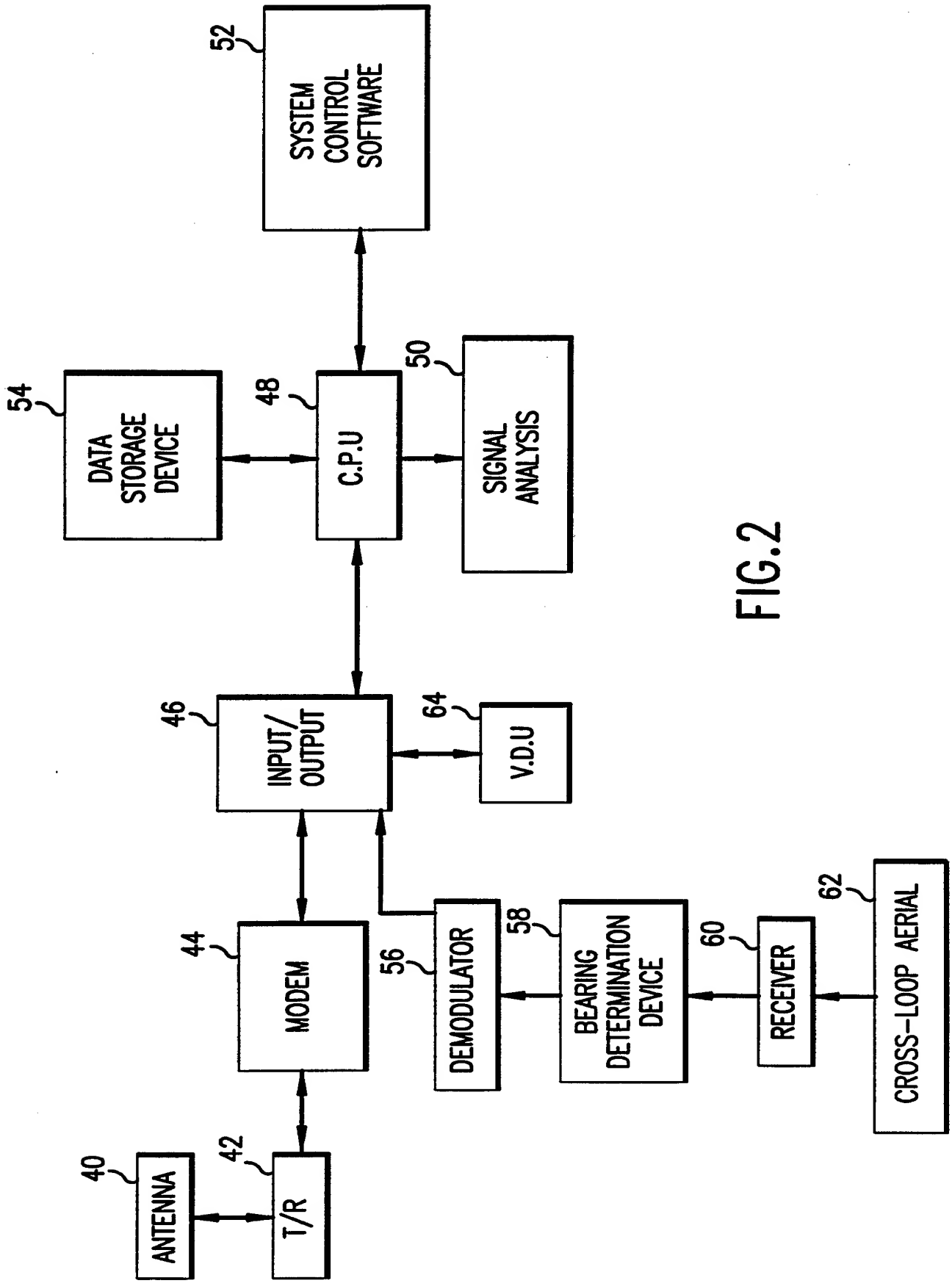
52
SYSTEM CONTROL SOFTWARE
54
DATA STORAGE DEVICE
48
C.P.U
50
SIGNAL ANALYSIS
46
INPUT/ OUTPUT
64
V.D.U
44
MODEM
56
DEMODULATOR
58
BEARING DETERMINATION DEVICE
60
RECEIVER
62
CROSS-LOOP AERIAL
40
ANTENNA
42
T/R

FIG.2

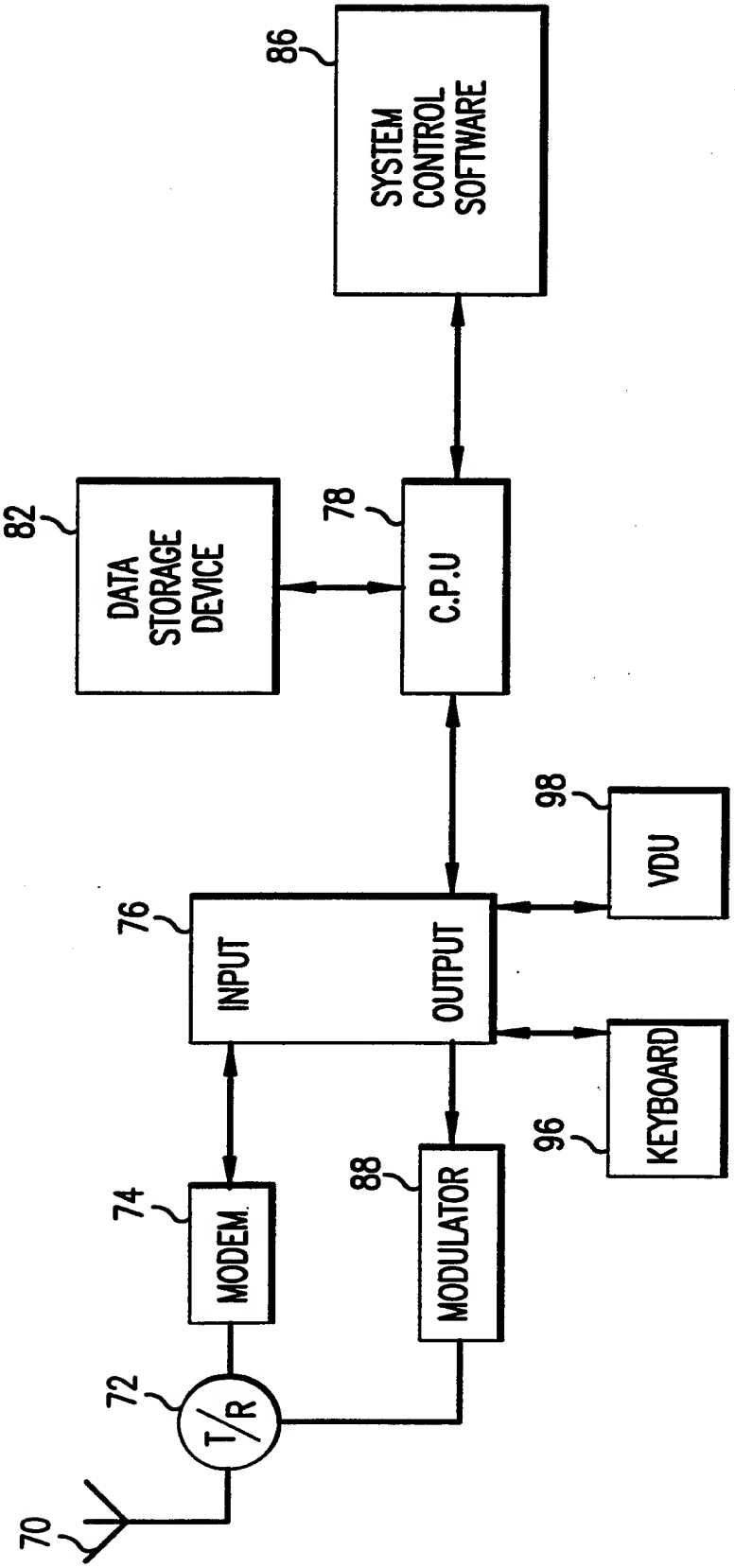
86
SYSTEM CONTROL SOFTWARE
82
DATA STORAGE DEVICE
78
C.P.U
98
VDU
76
INPUT
OUTPUT
96
KEYBOARD
74
MODEM
88
MODULATOR
72
T/R
70

FIG.3

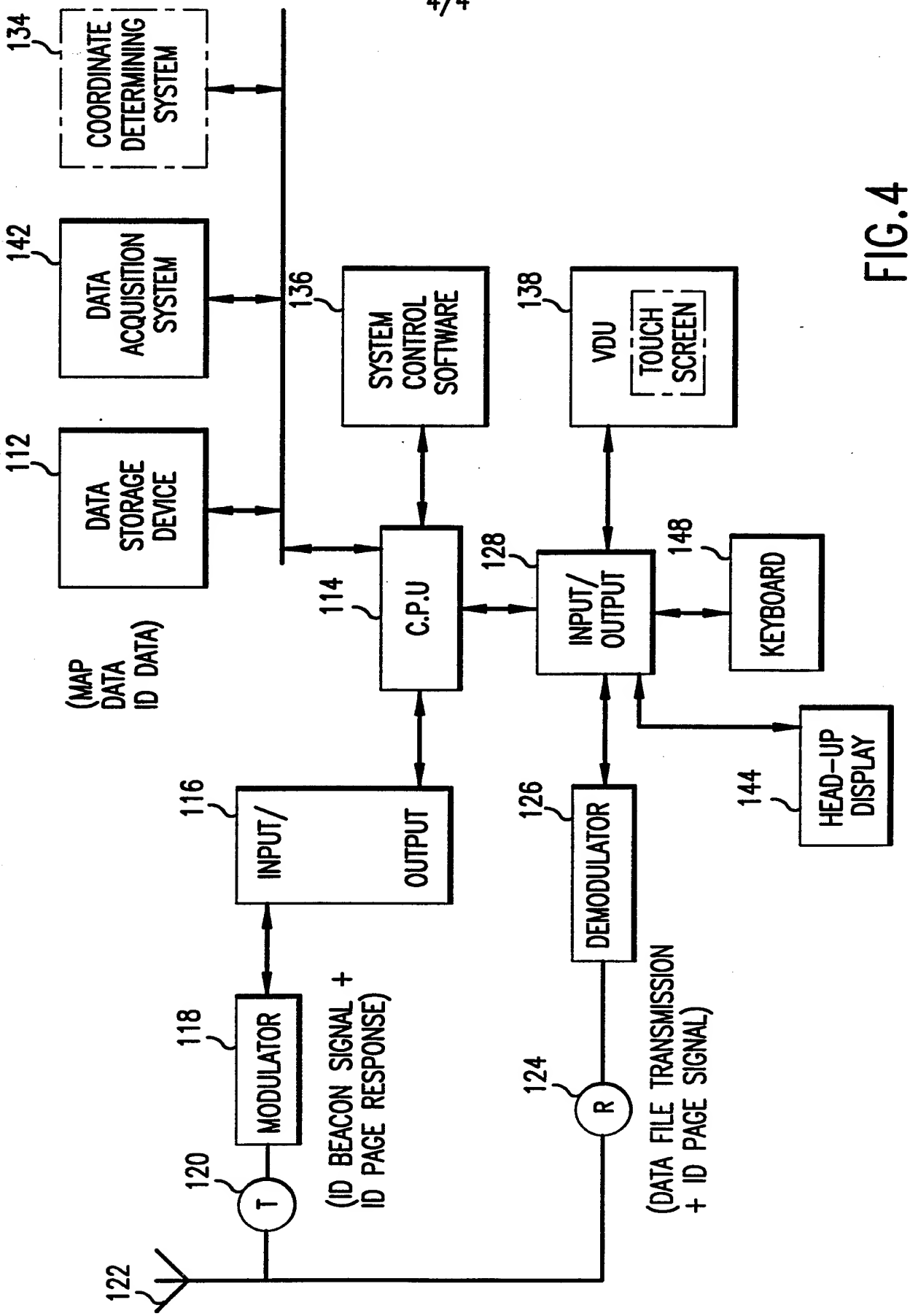
134
COORDINATE DETERMINING SYSTEM
142
DATA ACQUISITION SYSTEM
136
SYSTEM CONTROL SOFTWARE
138
VDU
TOUCH SCREEN
112
DATA STORAGE DEVICE
(MAP DATA ID DATA)
114
C.P.U
128
INPUT/ OUTPUT
148
KEYBOARD
116
INPUT/ OUTPUT
126
DEMODULATOR
144
HEAD-UP DISPLAY
118
MODULATOR
(ID BEACON SIGNAL + ID PAGE RESPONSE)
124
R
(DATA FILE TRANSMISSION + ID PAGE SIGNAL)
120
T
122

FIG.4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 94/01512

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G08G5/04 G08G3/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G08G G01S H04Q G08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US,A,5 111 400 (YODER) 5 May 1992 see the whole document	1-40
Y	EP,A,0 516 501 (SEXTANT AVIONIQUE) 2 December 1992 see the whole document	22,35
A	FR,A,2 601 168 (LMT RADIO PROFESSIONNELLE) 8 January 1988 see the whole document	1-7,14, 15
A	EP,A,0 484 918 (HUGHES AIRCRAFT COMPANY) 13 May 1992 see abstract	11-13

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 October 1994	09. 11. 94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Reekmans, M

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International Application No
PCT/GB 94/01512

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP,A,0 514 826 (TELEFUNKEN SYSTEMTECHNIK AG) 25 November 1992 see the whole document	1-7,14, 15
A	DE,A,34 00 602 (PRAKLA-SEISMOS GMBH) 18 July 1985	

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Information on patent family members

International Application No
PCT/GB 94/01512

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		EP-A-	0522040	13-01-93
		WO-A-	9114952	03-10-91
US-A-5111400	05-05-92	NONE		
EP-A-0516501	02-12-92	FR-A-	2677149	04-12-92
		US-A-	5340061	23-08-94
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		WO-A-	8800379	14-01-88
		JP-T-	1501177	20-04-89
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		CA-A-	2054361	08-05-92
		JP-A-	4267638	24-09-92
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		DE-A-	4223118	20-01-94
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